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Preferences of *Rusa timorensis* to Grasses and Their Body Morphometry and Velvet Antler Characteristics

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ABSTRACT

Timor deer (*Rusa timorensis*) is a wild native animal to Indonesia. The stags produce a high economic value of velvet antler (VA). This study was designed to evaluate the feed preference, nutrient consumption, age and morphometric of deer in relation to their velvet antler product (weight and length) and quality (mineral and amino acids). Five stags with three ages classes were offered 3 combinations of 4 grasses in a captive area. Grasses were offered for 3 periods of 12 consecutive days during velvet antler growth period. Velvet antlers were harvested at 36 days old and analysed for their chemical content. The result showed that Timor deer had different preference to the grasses offered. Deer had a high preference on the combination of *Pennisetum purpureum*, *Commelina benghalensis*, *Hierochloe horsfieldii*, and *Sorghum caudatum*. High intake of grasses increased body weight. The regression equation between the weight or length of velvet antler with age (year) and girth size (cm) were: $Y (\text{velvet antler weight}) = 0.43 + 0.03 (\text{age})$, $r^2 = 0.99$, $P < 0.05$, and $Y (\text{length of velvet antler}) = 5.7 + 0.31 (\text{girth size})$, $r^2 = 0.99$, $P < 0.05$. Aspartic acid, glutamic acid, and proline content of velvet antler were high in the older deer. The older deer having high girth size had the higher quality of velvet antler.

Key words: antler characteristic, deer, feed preference, velvet antler

ABSTRAK

Rusa Timor (*Rusa timorensis*) adalah satwa asli Indonesia. Rusa jantan dapat menghasilkan ranggah muda yang bernilai ekonomi tinggi. Penelitian ini bertujuan mendapatkan kaitan kesukaan rusa terhadap pakan, konsumsi nutrisi, umur dan morfometri rusa terhadap berat dan panjang serta kualitas mineral dan asam amino ranggah muda yang dihasilkan. Lima rusa jantan dengan tiga kelas umur diberi 3 kombinasi rumput, masing-masing terdiri atas 4 jenis dari 12 jenis pakan yang disukai di penangkaran. Pemberian pakan dilakukan selama 3 periode masing-masing selama 12 hari selama pertumbuhan ranggah muda. Ranggah muda dipanen setelah berumur 36 hari dan dianalisis kandungannya. Hasil penelitian menunjukkan bahwa Rusa Timor mempunyai preferensi berbeda terhadap rumput yang diberikan. Rusa sangat menyukai kombinasi jenis pakan *Pennisetum purpureum*, *Commelina benghalensis*, *Hierochloe horsfieldii*, dan *Sorghum caudatum* dengan asupan yang tinggi yang meningkatkan bobot badan. Berat dan panjang ranggah muda dipengaruhi berturut-turut oleh umur (tahun) dan lingkar dada (cm), mengikuti persamaan: $Y (\text{berat ranggah muda}) = 0,43 + 0,03 (\text{umur})$, $r^2 = 0,99$, $P < 0,05$; dan $Y (\text{panjang ranggah muda}) = 5,7 + 0,31 (\text{lingkar dada})$, $r^2 = 0,99$, $P < 0,05$. Kandungan aspartat, glutamat, dan proline lebih tinggi pada rusa yang lebih tua. Rusa yang berumur lebih tua dan memiliki lingkar dada lebih lebar memiliki produk dan kualitas ranggah muda lebih tinggi.

Kata kunci: karakteristik ranggah, rusa, preferensi pakan, ranggah muda

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INTRODUCTION

Timor deer (*Rusa timorensis* de Blainville 1822) is a wild native animal to Indonesia. However, during the least three generations (estimated as a minimum of 15 yr), deer population decreased by 10%, as a result of hunting activities. It was recorded that in 2008, the population of deer was about 10,000 heads (Hedges *et al.*, 2008). Therefore, IUCN has listed the timor deer in the vulnerable status (Hedges *et al.*, 2008). *Rusa* has been an genetic resources animal (Pattiselanno, 2003) and has high economic and estetic value (Wirdateti & Semiadi, 2007). Conservation of Timor deer has been a priority to minimize the reduction of their population. Utilization of velvet antler from the mature stag rather than slaughtering them to obtain their meat, is an alternative to conservation effort.

Velvet antler from deer has high concentration in Insulin Like Growth Factor (IGF-1), *glycosaminoglycans* (GAGs), vitamin A and E, uronic, and sialic acid (Tuckwell, 2003; Lee *et al.*, 2007). It is high in minerals (Ca, P, Mg, Na, Mn, Fe, and Se) and high in 8 essential amino acids and 15 non-essential amino acids (Kawtikwar, 2000). The velvet antler has been utilized as a component of Chinese medicine (Dradjat, 2000), as an anti aging and to improve the performance of athletes (Tuckwell, 2003; Lee *et al.*, 2007).

Quality of velvet antler is influenced by various factors including, genetic (strain, hibridization, selection), body size, age and harvest time (Gibbs, 2006), and development stage (Jeon *et al.*, 2011). Chemical composition of velvet antler indicates the amount and quality of feed that was consumed by the stag. Protein, Na, K and Mg contents (Estevez *et al.*, 2008) and growth of velvet antler of velvet antler (Kilgo & Labisky, 1995) were affected by protein, Ca, P, and Mg content of feed.

Length of yearly velvet in red deers (*Cervus elaphus*) is an indicator of the availability and quality of their feed as well as population condition (Schmidt *et al.*, 2001; Jeon *et al.*, 2006a). Nutritional deficiency resulted in negative impact on pedicle development in fawns and the growth of antlers in all age classes (Demarais, 2002). Velvet size indicates the age, health status and genetic of stag. Timor deer had 3 antler growth period, including casting period of 16.25 ± 0.88 d, velvet antler period of 155.75 ± 7.11 d, and hard antler period of 207.25 ± 2.75 d, and the total of yearly antler period period was 379.25 ± 2.75 d (Handarini, 2006). Velvet antler for medicinal purpose was harvested before day 60 (Dradjat, 2000). Nutrient intake contributed to the weight gain of the deer. Stewart *et al.* (2000) indicated that the ratio of velvet antler and body weight had positive correlation with age. Nutrient sufficiency and good population management result in healthy stag and high quality of velvet antler. The objectives of the present study were to evaluate the preference of deer on type of feed, nutrient intake, age and morphometric factors affecting weight, length and nutrients content of velvet antler.

MATERIALS AND METHODS

Time and Location

The preference of Timor deer on 20 type grasses was evaluated in the period of January 2011 to April 2011. In the period of Januari 2012 to April 2012, the most preferred of 12 grasses was combined randomly into 3 grass based diets composed of 4 type of grasses. The diets were offered to 5 deers for 3 consecutive 12 d periods in a captive area of the Conservation and Rehabilitation Center, Dramaga Forest Research. Harvest period of the velvet antlers which have nutritive compounds in Timor deer was 30-60 d. Therefore the feed preference trial for 20 grasses in the period of velvet antlers growth was conducted in 2011. The feed preference trial was conducted to evaluate and confirm the preference of the deer to 12 most preferred grasses. The trial was followed by the evaluation on physical and chemical characteristics of harvested velvet antler.

Data Collection and Analysis

Study of feed preference of timor deer to the most available grasses in the region (20 type of grasses) was conducted for 30 d period. Four type of grasses were selected randomly and offered to 5 deers for 6 consecutive days. Deer were kept in individual cages and offered a similar combination of grasses. Each type of grass was offered 1 kg in the morning and 1.25 kg in the afternoon, every day in four separate troughs, to allow the deer choose the grasses freely. The preference of deer on the grasses was based on the feed selection behavior with score 1 to 4. The most selected grasses eaten by the deer was scored 1. The feed selection behavior was recorded in the interval period of 10 min for 60 min. The weight of each grass consumed by the deer was recorded daily.

Five stags at the stage of velvet antler were used in the study. Three 3 yr old stags had body weight of 62.65, 48.73, 55.52 kg; and one 6 yr old stag had body weight of 62.40 kg and one of 9 yr old stag had body weight of 60.60 kg. The stags were kept in 1.5×2 m² individual cages.

In the first period of the study, 12 kinds of highly preferred grasses by the timor deer were randomly chosen as the component of three rations. Ration A was composed of *Sorghum candatum*, *Hierochloe horsfieldii*, *Commelina benghalensis* and *Pennisetum purpureum*; ration B was composed of *Scrophia sp.*, *Axonopus compressus*, *Caliandra calothyrsus* and *Leersia hexandra*; ration C was composed of *Cynodon dactylon*, *Panicum montanum*, *Setaria palmifolia* and *Coix lacryma*.

Grasses in each ration were offered individually to five experimental deers in separate feed trough in a cafeteria system (Babayemi *et al.*, 2006; Farid *et al.*, 2006; Rodriguez *et al.*, 2007). Each grass was offered 2.25 kg at 07.00 and 16.00. Ration A was offered for the first 12 d followed by 12 d period of feeding ration B and the last 12 d of feeding ration C. Residual of each grass rejected by the deer, after feeding for 24 h, was weighed separately. Samples of each grass offered and residual feed

rejected by the deer were collected and dried daily and then the samples were mixed at the end of the experimental period for chemical analysis.

During the second period of the study, body weight and body conformation including body height and length as well as heart girth of the deer were determined. The body conformation was determined on day 0 and 36. Weighing of the deer was conducted four times on day 0, 12, 24, and 36, before harvesting the velvet antler. Local anestacy using 4 ml *lignocain HCl* 2% (Wals & Wilson, 2002) was injected on the right and left side, at three points on pedical part.

A sterile iron saw was used to cut the velvet antlers. An antibiotic of Limoxin 25 was sprayed to cover the base of the velvet after cutting. Velvet antlers obtained were wilted on the updown position. Weight, length, diameter of velvet antlers were determined. Samples of velvet were stored in 4 °C for 2-3 d before measurement and chemical analysis. The velvet antlers were dried in an oven at 45 °C for two periods of 6 hours. The velvet antlers were placed out side the oven for 1-2 h before the second period of drying. The fine hair of velvet antlers were cleaned by quick burning. Finally the dry velvet antlers were sliced and ground for chemical analysis. Dry matter, ash, ether extract, crude protein, crude fiber, mineral and amino acids contents of the velvet antlers of the deer were determined. Descriptive statistical analysis was applied to determine the factors influencing the weight and chemical composition of the velvet antler.

RESULTS AND DISCUSSION

Feed Preference

The type of grasses and their score according to the feed selection behavior are indicated in Table 1. Timor deer preferred to select almost all of the grass type offered during the study. The score varied from 1.62 to 3.80. The preference of the deer to the grass was likely influenced by the physical and chemical characteristic of the grass. The first 12 grasses were the most available grasses in the region and they indicated low score, which mean that thay were preferred by the timor deer.

Feed Intake

Total dry matter intake and the intake of each grass offered to the Timor deers were shown in Table 2. Timor deer at age of 3-9 yr old having body weight of 59.18±7.07 kg had the dry matter intake of 834–1549 g/d. Type of grass and age of timor deer influenced the total dry matter intake. The deer indicated different preference on grass type. In the present study, the dry matter intake of ration A was higher in all age classes. Timor deer indicated the high intake of *P. purpureum* and *C. benghalensis*, *H. horsfieldii* and *S. candatum* (Table 2). The preference of the deer on the grass might be influenced by physical characteristics and nutrients content of the grass (Ceacero *et al.*, 2010). Intake of mixed grass might have supplementary effect among the grass to meet nutrients requirement of the deer, but feeding low palatability grass reduced the total dry matter intake.

Timor deer offered grass had total dry matter intake of 28±3, 24±1, and 26±1 (g/kg BW/d), at age of 3, 6, and 9 yr old, respectively. The younger deer indicated high dry matter intake, since they likely need more nutrients for maintenance and their growth. Grass had low energy and protein content, therefore they were able to utilize the ingested nutrients efficiently for their maintenance and their growth.

High dry matter intake of ration A increased body weight by 91 g/d in the 12 d feeding period. On the other hand, the deer indicated reduction in body weight of 1.41 kg and 0.75 kg in the period of 12 d of feeding ration B and C, respectively. Increased in body weight could be the result of the increase in energy and protein intake. Afzalani *et al.* (2008) reported that high energy and protein intake improved the body weight. Combination of different grass with high palatability in the ration might improve the body weight of the deer.

The results indicated that the Timor deer offered grass in a cafeteria system allowed them to choose the grass, increased dry matter intake and improved their body weight. On the other hand, a sufficient ammount of the grass with low palatability might not improve the body weight of the deer, since they had low dry matter intake. Body weight indicated low corelation with velvet

Table 1. Score of the preference of Timor deer on the type of grasses in a captive area

No	Local name	Scientific name	Score	No	Local name	Scientific name	Score
1	Hopea	<i>Scrophia sp</i>	1.62	11	Cacabean	<i>Asystasia spp</i>	2.64
2	Sulanjana	<i>Hierochloe horsfieldii</i>	2.00	12	Alang-alang	<i>Imperata cylindrica</i>	2.65
3	Sauheun	<i>Setaria palmifolia</i>	2.02	13	Bayondah	<i>Isachne globosa</i>	2.65
4	Sorgum	<i>Sorghum candatum</i>	2.27	14	Gewor	<i>Commelina benghalensis</i>	2.74
5	Papadian	<i>Leersia hexandra</i>	2.28	15	Kaliandra	<i>Caliandra calothyrsus</i>	2.82
6	Setaria	<i>Setaria sphacelata</i>	2.30	16	Hanjeli	<i>Coix lacryma</i>	2.88
7	Kipait	<i>Axonopus compresus</i>	2.33	17	Kaw. merah	<i>Cynodon spp</i>	2.90
8	Rumput gajah	<i>Pennisetum purpureum</i>	2.33	18	Kawatan	<i>Cynodon spp</i>	3.00
9	Aawiyen	<i>Panicum montanum</i>	2.52	19	Kawatan besar	<i>Cynodon spp</i>	3.35
10	Kacangan	<i>Centrosema pubescens</i>	2.54	20	Mekania	<i>Mikania micrantha</i>	3.80

Table 2. Daily dry matter intake of three different age classes and body weight (BW) of the deers in a captive area

Age class (year)	3	6	9	
Body weight (kg)	55.63	62.4	60.6	Mean
n	3	1	1	
Ration A, (g/h/d)				
<i>Sorghum candatum</i>	328 ± 9 ^d	332 ± 2 ^b	331 ± 4 ^c	329 ± 7
<i>Hierochloe horsfieldii</i>	361 ± 21 ^c	375 ± 1 ^{ab}	376 ± 1 ^b	367 ± 18
<i>Commelina benghalensis</i>	397 ± 16 ^b	402 ± 21 ^a	396 ± 32 ^b	398 ± 19
<i>Pennisetum purpureum</i>	463 ± 17 ^a	416 ± 46 ^a	446 ± 26 ^a	450 ± 30
Mean, (g/h/d)	387 ± 53	381 ± 40	387 ± 47	385 ± 10
Total intake, (g/h/d)	1,549 ± 42 ^{A(A)}	1,526 ± 56 ^{A(A)}	1,549 ± 45 ^{A(A)}	1,424 ± 62
(g/kg BW/d)	28 ± 3	24 ± 1	26 ± 1	27 ± 3
Ration B, (g/h/d)				
<i>Scrophia sp</i>	176 ± 19 ^b	195 ± 4 ^a	198 ± 0.3 ^a	184 ± 18
<i>Axonopus compresus</i>	246 ± 56 ^a	268 ± 58 ^a	272 ± 32 ^a	255 ± 50
<i>Caliandra calothyrsus</i>	169 ± 67 ^b	226 ± 84 ^a	242 ± 66 ^a	195 ± 72
<i>Leersia hexandra</i>	243 ± 45 ^a	287 ± 47 ^a	267 ± 52 ^a	257 ± 47
Mean, (g/h/d)	209 ± 32	244 ± 37	245 ± 37	223 ± 34
Total intake, (g/h/d)	834 ± 122 ^{B(B)}	976 ± 185 ^{A(B)}	979 ± 144 ^{A(B)}	891 ± 148
(g/kg BW/d)	15 ± 3	16 ± 3	16 ± 3	16 ± 3
Ration C, (g/h/d)				
<i>Cynodon dactylon</i>	249 ± 31 ^{ab}	259 ± 48 ^{bc}	245 ± 59 ^b	250 ± 37
<i>Panicum montanum</i>	202 ± 28 ^b	227 ± 16 ^c	234 ± 7 ^b	213 ± 27
<i>Setaria palmifolia</i>	251 ± 47 ^{ab}	308 ± 1 ^b	308 ± 34 ^b	273 ± 48
<i>Coix lacryma</i>	291 ± 141 ^a	454 ± 59 ^a	421 ± 65 ^a	350 ± 135
Mean, (g/h/d)	248 ± 81	312 ± 87	302 ± 88	287 ± 47
Total intake, (g/h/d)	992 ± 211 ^{B(B)}	1,248 ± 98 ^{A(B)}	1,208 ± 149 ^{A(B)}	1,087 ± 211
(g/kg BW/d)	18 ± 4	20 ± 2	20 ± 3	19 ± 4

Note: Means in the same column and diet with different superscript differ significantly ($P < 0.05$); Means in the same row with different capital superscript differ significantly ($P < 0.05$); Total value in the same column with different capital superscript parenthesis differ significantly ($P < 0.05$).

weight (Drajat, 2000). However, there was a high correlation between the ratio of velvet to body weight with the age of deer (Stewart *et al.*, 2000). Therefore, increasing body weight of the deer was important to obtain the high weight of velvet antler.

Nutrients Intake

Means of daily nutrients intake of three different age classes of Timor deers in a captive area are indicated in Table 3. There was no different nutrient intake of ration A, B and C among the deer in three different classes. There was a tendency that the younger deer had high dry matter intake. Luna *et al.* (2013) found that deers with smaller body weight were likely able to select and consume a higher quality diet.

Rations B and C supplied lower protein to the deer. However, the deer in the same class indicated different nutrients intake. The pattern of nutrients intake of ration A, B, and C were similar with that of dry matter intake. Each grass as the component of a diet contributed to the total of ingested nutrients, but the lower palability of

the grass the lower the dry matter and nutrients intake contributing to the total of ingested dry matter and nutrients from the ration. High nutrient content grass had high dry matter intake. The deer indicated difference preference to the grass offered in three different rations, and therefore resulted in the variation of the ingested nutrient. *P. purpureum* indicated the highest palatability and dry matter intake in ration A, on the other hand *H. horsfieldii* had the lowest palability and dry matter intake.

The reduction of body weight during feeding rations B and C was likely as a result of low dry matter and protein intake. Although the increased in body weight during feeding ration A was partly associated with convensatory growth, but the protein intake at 32 g/d was likely adequate to meet the protein requirement for maintainant and it allowed to increase body weight. Protein sufficiency indicated a significant effect on the growth velvet antler, although the protein intake had no effect on nutrient composition of the velvet antler of spotted deer (Jeon *et al.*, 2006b). The growth of velvet antler was reduced by low protein intake (Shin *et al.*,

Table 3. Mean of individual daily nutrients intake of three different age classes of Timor deers in a captive area

Age class, years	3	6	9	Mean	Signif.
Body weight, kg	55.63	62.4	60.6		
n	3	1	1		
Ration A (g/h/d)					
Dry matter	1,549±212	1,526±147	1,549±192	1,544±188	0.861
Ash	167± 30	165± 35	167± 32	167± 32	0.924
Crude protein	207± 30	204± 20	207± 28	207± 27	0.864
Crude fiber	710±121	699± 97	710±120	707±111	0.886
Ether extract	23± 17	23± 19	23± 19	23± 17	0.983
Nitrogen free extract	443± 77	435± 61	442± 71	441± 69	0.887
Ration B (g/h/d)					
Dry matter	834±194	976±164	979±136	891±185	0.238
Ash	88± 34	103± 44	102± 39	94± 38	0.590
Crude protein	152± 30	180± 38	182± 47	163± 36	0.204
Crude fiber	309± 95	359± 86	360± 82	329± 90	0.410
Ether extract	6± 2	7± 2	7± 2	7± 2	0.516
Nitrogen free extract	280± 71	329± 74	329± 62	299± 71	0.299
Ration C (g/h/d)					
Dry matter	992±295	1,248±401	1,208±344	1,086±329	0.247
Ash	131± 40	166± 57	161± 50	144± 46	0.261
Crude protein	169± 70	218±107	211± 96	187± 81	0.386
Crude fiber	370±100	458±101	444± 89	402±101	0.194
Ether extract	28± 14	35± 21	34± 18	30± 16	0.487
Nitrogen free extract	294±104	372±149	360±117	323±117	0.331

2000). Therefore, to improve the productivity of the deer, it is necessary to offer a high protein ration (Sookhareea & Dryden, 2004).

Ration A indicated high dry matter and fiber intake in all age classes of the deer. However, in most animal, high dry matter intake is associated with low fiber intake. Sambar deer (*Cervus unicolor*) indicated a high preference to low fiber diets. High fiber diet reduced dry matter intake (Afzalani *et al.*, 2008), since fiber component of ingested feed increases ruminal retention time. Fibrous feeds indicate high bulkiness. High intake of fibrous feed creates high tension to the rumen wall and stimulate satiety effect and decreases dry matter intake (Toharmat *et al.*, 2006). Low dry matter intake was highly correlated with low nutrient digestibility and the high rate of feed particles passage, which were mostly dictated by the level of fiber intake (Tafaj *et al.*, 2005). A high fiber intake in Timor deer indicated that the deer were adapted and tolerant to the high fiber diet.

Minerals Intake

Intake of macro mineral in deer at different age is presented in Table 4. Phosphorus and S intake of deer were higher in A ration than that in B and C rations. On the other hand, Ca and Mg intake were similar in all rations. Mineral intake was not affected by deer age. Sufficiency

of P, Ca, Mg, and S intake, allowed the normal growth of velvet antler and tissue. Some grasses indicated low content of macro minerals. To meet the requirement of essential macro minerals, the dietary supplementation of P and Ca was likely necessary in deer offered grasses as a sole ration.

Intake of macro mineral of deer at different age classes in each diet was not different ($P < 0.05$). However, the macro mineral intake differed among diets, which was the highest in ration A. Intake of Ca, P, Mg, and S was 14.6, 5.7, 5.02, and 7.56 g/kg body weight. Intake of the Ca, Mg and S met the requirement of deer, but the intake of P was lower than that required.

McDonald *et al.* (2011) reported that Ca, P, Mg, and S content of the deer body was 15, 10, 0.4, and 1.5 g/kg body weight, respectively. In adult animal, Ca deficiency resulted in osteomalacia indicated by reduction of bone strength. On the other hand, deficiency of P resulted in abnormal appetite indicated by beating foreign material around cage (McDonald *et al.*, 2011). Nowicka *et al.* (2006) reported that mineralization of velvet and head bone was affected by age and environmental condition of the animal. Calcium content of velvet was 133.96 mg/g, which was higher than the Ca content of head bone of 123.79 mg/g, in vice versa for P, which was 83.58 mg/g velvet and 84.62 mg/g of head bone.

Table 4. Mean of daily macro mineral intake of Timor deer in different age class in a captive area (g/d)

Age class, year	3	6	9	Mean	Signif.
Body weight, kg	55.63	62.4	60.6		
n	3	1	1		
Ration A					
Calcium	14.60±0.30	14.60±0.50	14.60±0.70	14.60±0.40	0.965
Phosphor	5.70±0.10	5.70±0.20	5.70±0.10	5.70±0.10	0.514
Magnesium	5.06±0.11	4.95±0.21	5.05±0.16	5.02±0.15	0.462
Sulphur	7.53±0.06	7.57±0.10	7.58±0.10	7.56±0.08	0.533
Ration B					
Calcium	8.10±1.00	9.50±1.70	9.60±1.30	9.04±1.40	0.244
Phosphor	2.10±0.30	2.50±0.50	2.50±0.40	2.30±0.40	0.279
Magnesium	2.99±0.33	3.41±0.58	3.50±0.44	3.32±0.47	0.236
Sulphur	2.23±0.24	2.61±0.61	2.68±0.43	2.51±0.44	0.285
Ration C					
Calcium	9.70±2.70	12.60±1.00	12.20±1.40	11.50±2.10	0.107
Phosphor	3.90±1.00	5.10±0.40	4.90±0.60	4.60±0.80	0.108
Magnesium	4.04±1.11	5.64±0.45	5.10±0.64	4.81±0.89	0.108
Sulphur	3.17±0.87	4.16±0.39	3.98±0.53	3.77±0.71	0.113

The total of 70% body Mg is deposited in the skeleton and the remainder is deposited in soft tissue and body fluid (McDonald *et al.*, 2011). Magnesium intake in the present study was higher than that required, since some grasses, such as *Coix lacryma* and *Scrophia sp.* were high in Mg. However, to increase the intake of Ca and P in deer offered grass based diet, dietary supplementation of these minerals is necessary, to reduce the excessive mobilization of the mineral from the bone.

Intake of P and Ca was 0.6-0.7 and 0.3-0.4 mg/kg body weight of the deer, respectively. The values was lower than P and Ca required by the deer. McDonald *et al.* (2011) reported that the macro minerals in the body tissue of deer were 15, 10, and 0.4 g/kg for Ca, P, and Mg. Supplementation of Ca and P to meet the normal growth may minimize resorption of these minerals at the rate of 25 g/d from their bone, during the peak growth of velvet antler. Nowicka *et al.* (2006) reported that the mineralization of velvet antler and head skeleton in the deer was influenced by age and their environment condition. Calcium content of velvet antler and head skeleton was 133.96 and 123.79 mg/g, respectively. Velvet antler and head skeleton of the deer contained Ca and P of 84.62 and 83.58 mg/g, respectively.

Intake of Fe, Mn, Cu, and Zn in deer at different age is presented in Table 5. There was no different in micro minerals intake in deer offered different rations. However, the micro mineral intake of the deer in the same age class differed significantly among rations. High intake of micro minerals was observed in the deer offered ration A.

Micro mineral intake of deer was higher when the deer were offered ration A. Iron (Fe), Mn, Cu and Zn content in body tissue of the deer was 20-80, 0.2-0.6 mg/kg, 1-5, and 10-50 mg/kg, respectively (McDonald

et al. 2011). Intake of the micro minerals of the deer fed grasses based diets was likely met the requirement.

Velvet Antler Characteristic

Mean of body morphometry of Timor deer in different age class kept in a captive area is presented in Table 6. Length of velvet antler of the Timor deer was clasified into E class. Mean of velvet antler diameter of Timor deer was 28.18±4.36 mm. Handarini (2006) reported that main part of velvet had diameter of 39.03±6.86 mm. The different in diameter of velvet antler might be associated with the time of harvesting and ingested nutrients. Diameter of the velvet antler was not in the range values for grading velvet antler for red deer (*C. elaphus*). Clasification of velvet antler for red deer was based on its length and diameter at 55-60 d old, whereas the length and diameter of velvet antler is seted in the range of 11-16 and 30-40 cm, respectively. Timor rusa has different physical characteristic with red deer, Timor deer has smaller body size and shorter body length then the red deer.

At 3, 6, and 9 yr old, Timor deer produces 0.5, 0.6, and 0.7 kg velvet antler, respectively. Dradjat (2000) reported that Timor x Sambar cross breed deer produced 1.34±0.23 kg of velvet antler. Sambar deer kept in a captive area produced velvet antler of 0.69 kg/pair which had length of 20.49-21.37 cm (Jamal *et al.*, 2005). Although, Sambar deer had higher body weight, the deer produced lower weight and shorter velvet antler than that of Timor deer when they kept in a captive area. Cross breed Sambar x Timor deer produced havier and longer velvet antler than both breeds. The result indicated that clasification of velvet antler should be based on the type of deer.

Weight and diameter of velvet antler harvested on day 60 from Timor deer had high correlation with the age and girth diameter of the deer. The regression equation of weight and age was expressed as follows: $Y = 0.4 + 0.03X$; $r^2 = 99\%$; $P < 0.05$, Y = weight of velvet antler and X = age. The regression equation of length and girth diameter was expressed as follows: $Y = 5.7 + 0.31X$, $r^2 = 99\%$, $P < 0.05$, Y = length of velvet antler and X = girth diameter. Handarini (2006) reported that the velvet antler indicated a maxi-

um length at a given age, that followed the sigmoid curve.

Minerals and Amino Acids Content of Velvet Antler

Macro and micro minerals content of velvet antler harvested on day 36, from Timor deer in different age classes are presented in Table 7 and 8. Macro and micro mineral content of velvet antler harvested on day 36

Table 5. Mean of daily micro mineral intake of Timor deer in different age class in a captive area

Age class (yr)	3	6	9	Mean	Signif.
Body weight, kg	55.63	62.4	60.6		
n	3	1	1		
Ration A					
Fe, g/d	0.920 ± 0.020	0.900 ± 0.020	0.910 ± 0.030	0.910 ± 0.030	0.507
Mn, g/d	0.340 ± 0.010	0.340 ± 0.010	0.340 ± 0.020	0.340 ± 0.010	0.712
Cu, g/d (x10 ⁻²)	0.990 ± 0.020	0.980 ± 0.020	0.990 ± 0.030	0.990 ± 0.020	0.786
Zn, g/d	0.074 ± 0.001	0.072 ± 0.002	0.073 ± 0.002	0.073 ± 0.002	0.417
Ration B					
Fe, g/d	0.510 ± 0.050	0.590 ± 0.090	0.580 ± 0.080	0.560 ± 0.080	0.307
Mn, g/d	0.180 ± 0.020	0.210 ± 0.020	0.210 ± 0.020	0.200 ± 0.030	0.139
Cu, g/d (x10 ⁻²)	0.690 ± 0.100	0.820 ± 0.100	0.840 ± 0.130	0.780 ± 0.140	0.259
Zn, g/d	0.025 ± 0.003	0.030 ± 0.005	0.030 ± 0.005	0.028 ± 0.005	0.293
Ration C					
Fe, g/d	0.450 ± 0.080	0.530 ± 0.070	0.520 ± 0.070	0.500 ± 0.070	0.173
Mn, g/d	0.290 ± 0.050	0.350 ± 0.050	0.350 ± 0.030	0.330 ± 0.040	0.128
Cu, g/d (x10 ⁻²)	1.220 ± 0.400	1.670 ± 0.360	1.600 ± 0.210	1.500 ± 0.320	0.099
Zn, g/d	0.047 ± 0.012	0.059 ± 0.009	0.058 ± 0.006	0.055 ± 0.008	0.109

Table 6. Mean of body morphometry of Timor deer in different age class kept in a captive area

Age (yr)	Morphometry measurement								
	Velvet weight (kg)	Velvet length (cm)	Branch length (cm)	Velvet diameter (mm)	Velvet age (d)	Body weight (kg)	Body length (cm)	Heart girth (cm)	Body height (cm)
3	0.5	26	13	26	60	55	78	66	76
6	0.6	31	14	30	60	62	88	83	83
9	0.7	32	15	34	65	61	84	86	84

Table 7. Macro mineral content of velvet antler harvested on day 60, from Timor deer in different age classes

Age class (yr)	Body weight (kg)	n	Macro minerals (g/kg DM)			
			P	Ca	Mg	S
3	55.63	3	49.96±1.60 ^c	25.76±0.83 ^c	1.03±0.03 ^c	1.08±0.03 ^c
6	62.40	1	57.63±0.64 ^b	29.72±0.32 ^b	1.19±0.01 ^b	1.24±0.01 ^b
9	60.60	1	67.62±0.92 ^a	34.87±0.47 ^a	1.40±0.02 ^a	1.46±0.02 ^a
Mean			55.03±7.32	28.38±3.78	1.14±0.15	1.19±0.16

Note: Means in the same column with different superscript differ significantly ($P < 0.05$).

from timor deer in different age class. Macro and micro minerals content, of velvet antler, were higher in the older deer than those in younger deer.

Quality of velvet antler is based upon its protein content indicating by amino acids composition. Protein content of velvet antler was negatively correlated with the Ca content. The increase in Ca content, which is inline with the growth of velvet antler, results in a decrease in protein content and therefore its total amino acids, uronic acid, and sialic acid content decrease. On the other hand, the increase in Ca is associated with the increase in ash and collagen content of the velvet, and therefore reduces the quality of velvet (Jeon *et al.*, 2009).

Amino acids content of velvet antler harvested on day 36 from Timor deer in different age classes is presented in Table 9. There was no different in essential amino acid content of velvet antler among age classes of the deer. Most essential amino acids in the velvet

antler were likely not affected by the intake of protein or other nutrients. However the nutrient intake might increase the total weight of velvet antler, therefore they increased the total of nutrients including amino acids as components of the velvet antler. Aspartic acid, glutamic acid, and proline content in velvet antler were high in the older deer. The older deer indicated higher metabolism activity in synthesizing non-essential amino acids and deposited the amino acids in the velvet antler.

CONCLUSION

Timor deers indicate different preference to the available species of grasses and has the highest preference to ration composed of *P. purpureum*, *C. benghalensis*, *H. horsfieldii*, and *S. caudatum*. High intake of grasses increase body weight of the deer but it does not change the composition of nutrient in the velvet antler of the

Table 8. Micro mineral content of velvet antler harvested on day 60 from Timor deer in different age class

Age class (yr)	Body weight (kg)	n	Micro minerals (mg/kg DM)			
			Fe	Mn	Cu	Zn
3	55.63	3	260.35± 8.34 ^c	2.25±0.07 ^c	58.35±1.87 ^c	130.17± 4.17 ^c
6	62.40	1	300.33± 3.29 ^b	2.59±0.03 ^b	67.31±0.73 ^b	150.16± 1.64 ^b
9	60.60	1	352.37± 4.78 ^a	3.04±0.05 ^a	78.98±1.07 ^a	176.19± 2.38 ^a
Mean			286.75±38.14	2.47±0.33	64.27±8.55	143.37±19.07

Note: Means in the same column with different superscript differ significantly (P<0.05).

Table 9. Amino acids content of velvet antler harvested from Timor deer in different age class (mg/kg DM)

Age class (yr)	3	6	9	Mean
	55.63	62.4	60.6	
	n	3	1	
Asp	11.25±3.01 ^c	19.23±1.73 ^b	25.55±2.47 ^a	15.70± 6.60
Glu	15.97±3.46 ^c	35.63±1.46 ^b	43.39±3.39 ^a	25.38±12.75
Ser	8.03±3.36	5.67±0.55	7.91±0.40	7.53± 2.70
Gly	8.85±4.89	6.66±0.68	10.31±2.21	8.70± 3.93
His*)	8.73±2.92	5.24±0.78	7.64±0.64	7.81± 2.62
Arg*)	7.81±2.92	5.81±1.04	10.56±0.18	7.96± 2.72
Thr*)	7.25±4.32	5.79±0.59	8.56±0.03	7.22± 3.36
Ala	7.31±4.84	4.70±0.11	6.36±0.62	6.60± 3.77
Pro	6.40±1.22 ^c	9.68±0.45 ^b	13.46±0.86 ^a	8.47± 3.10
Tyr	7.36±4.71	5.16±0.17	7.00±0.35	6.85± 3.63
Val*)	7.68±3.44	4.32±0.30	6.20±0.10	6.71± 2.92
Met*)	8.39±4.02	4.89±0.25	5.97±0.47	7.21± 3.38
Sis	5.90±2.32	3.87±0.17	4.75±0.18	5.26± 1.94
Ile*)	7.10±4.71	9.47±0.32	11.86±1.26	8.52± 4.06
Leu*)	9.85±4.09	10.50±0.34	12.99±1.44	10.61± 3.34
Phe*)	7.65±3.24	5.81±0.45	6.78±0.51	7.10± 2.55
Lys*)	9.08±3.72	6.78±0.51	7.39±0.74	8.28± 2.98

Note: *)Essential amino acids

deer. Age of the deer is the determinant of the weight of velvet antler and the hearth girth is the determinant factor of length of the velvet antler. Older deers have higher non essential amino acids. However, age and nutrient intake have no effect on amino acids composition of velvet antler.

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